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Original Article

ANALYZING ROUTING PROTOCOL BASED ON BAT ALGORITHM FOR SPARELY AND DENSELY DEPLOYMENT OF SENSORS IN WIRELESS SENSOR NETWORK

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ABSTRACT

Wireless Sensor Network (WSN) is the network of energy constrained sensor nodes deployed within an area for monitoring physical and environmental conditions. WSN has been used for various applications such as Health Care, Home Intelligence, Environmental Monitoring and etc. Sensor Nodes after sensing the data forwards to the Base Station from where, it is analyzed. Increasing the lifetime of a sensor network is one of the most important research works for the researchers in this field. One of the way in which we can increase the lifetime of sensor network is by optimizing the Cluster Head selection. This paper focuses on using Bat Algorithm as an optimization algorithm for Cluster Head selection and then compares with ModLeach and finally analyzes it in sparely and densely deployment of sensors by varying BS location and initial energy of sensor nodes. Simulation has been done in MATLAB.

KEYWORD: Wireless Sensor Network, Network Lifetime, BS, CH Etc

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INTRODUCTION

Wireless Sensor Network is a network of sensor nodes distributed over an area for monitoring environmental conditions. Deployment of Sensor Nodes can either be dense or sparse deployment but when fine grain monitoring is required dense deployment is preferred. There are various phases in operation of WSN. They are as follows:

- **Planning Phase:** In this phase the area where nodes are to be deployed is monitored.
- **Deployment Phase:** As the name is depicting deployment of the nodes in the area monitored in planning phase is done in this phase.
- **Post-Deployment Phase:** In this phase positioning of the respective sensors by the operator of the sensor network is done.
- **Operation Phase:** In this phase sensors perform respective operations for which they are designed.
- **Post Operation Phase:** In this Phase shutting down and dismantling of the sensors is done.
- Out of all these phases deployment phase and operation phase are most important phases and most of the

research work focuses on them.

Some of the fields where WSN is used are as follows: Industrial Process Control, Military, Health Care, Home Intelligence, Hazard Monitoring and etc

BAT ALGORITHM

Bat algorithm is a metaheuristic algorithm used for global optimization developed by Xin-She Yang in 2010.

Solutions/Best set of nodes as CHs found are based on Fitness Function used is an objective function and depends on the transmission distance. The fitness of the node increases as the distance decreases.

MOTIVATION

Cluster-Head selection plays a very important role in ensuring longer network lifetime to a WSN. Many routing algorithm have been designed that considers more than one factor of sensor node (for eg. residual energy, no. of sensors present in each sensor, probability to become CH and etc) for CH selection so as to ensure longer network lifetime. Along with that CH selection can further be optimized by using any one of the Optimization Algorithms. This research focuses on using Bat algorithm for optimizing cluster head selection and then analyzing it by varying the Base-Station location and initial energy of sensor nodes. As no work has been done related to its analysis in different deployment of Sensor Nodes.

SYSTEM MODEL

- **Network Model**

Homogeneous Network Model is taken into consideration which means all sensor nodes have same initial energy levels. N number of nodes are deployed in a region comprising of Ch clusters with each cluster comprising of N/Ch number of sensor nodes.

- **Energy Model**

First order radio model is used for energy dissipation. This model defines energy to be used by sensors for transmitting, receiving and aggregating data.

Energy consumed for transmitting k bit size packet over distance d is as follows:

$$E_{Tx}(k,d) = \begin{cases} k * E_{elec} + k * E_{fc}\, d^2 & d \leq d_0 \\ k * E_{elec} + k * E_{mp}\, d^4 & d > d_0 \end{cases}$$

where $d_0 = \sqrt{E_{fc}/E_{mp}}$ and E_{elec}=50J/bit

Energy consumed for receiving k bit size packet is given below:

$$E_{Rx}(k,d) = k^* E_{elec}$$

SIMULATION RESULTS AND DISCUSSION

This section discusses the results of simulation and analyzes them. Simulation has been done in Matlab. Table 1 defines the Simulation Parameters used in this research work.

Table 1: Simulation Parameters

Parameters	Values
Simulation Area Size	200 m x200 m
Number of nodes	80,160
Base station position	(100,100) ad (260,280)
Data Packet size	4000 bits
Transmission & Receiving Energy (E_{elec})	50 nJ/bit
Free space Transmitter Amplifier Energy ($\in_{fs}$)	10 pJ/bit/m^2
Multipath fading Transmitter Amplifier energy ($\in_{mp}$)	.0013 pJ/bit/m^4
Data Aggregation Energy (E_{DA})	5 nJ
Type of distribution	Random

Network Performance parameters taken for analyses are as follows:

- **Network Lifetime**

It is defined as the time (in terms of rounds) when the last sensor node dies. Maximization of the Network Lifetime is one of the most important areas of research for the researchers in the field of WSN.

- **Packets to CHs**

It is defined as the total no. of packets send to the cluster heads by the sensor nodes.

Comparing Routing Protocol Based on Bat Algorithm with Modleach

- **Network Lifetime**

Figure 1: shows network lifetime of a sensor network implementing Bat based routing and Modleach in form of Last Node Dead and concludes that implementing Bat based routing approach prolongs network lifetime.

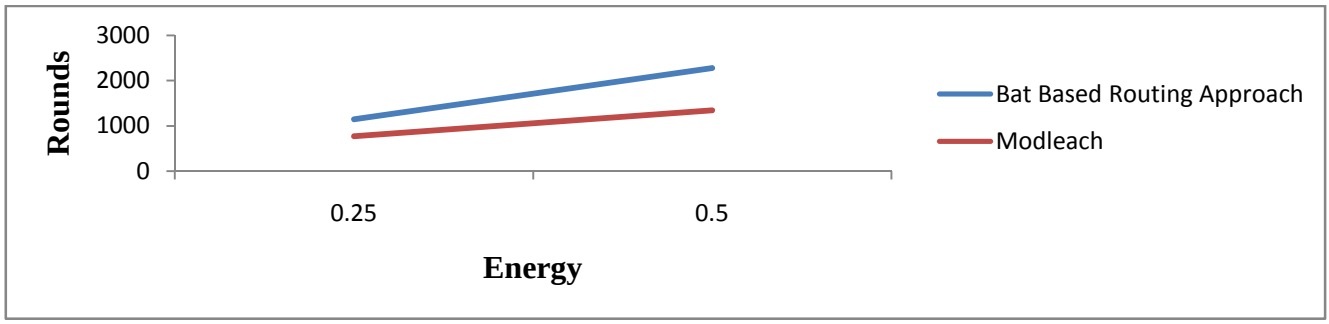

Figure 1: Network Lifetime of a Sensor Network Implementing Bat Based Routing and Modleach

- **Packets to Cluster Heads**

Figure 2: shows no. of packets sent to cluster head by all the sensor nodes throughout the lifetime of the network and concludes that more packets are delivered to cluster heads when Bat based routing is implemented in comparison to implementing Modleach.

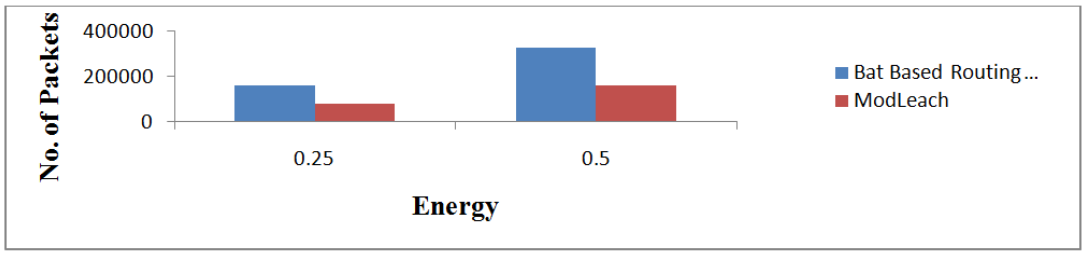

Figure 2: Packets Sent to Cluster Heads Implementing Bat Based Routing and Modleach

Analyzing Routing Protocol Based on Bat Algorithm for Sparely Deployment and Densely Deployment of Sensor Nodes

This section summarizes the results of analysis of Routing Protocol based on Bat Algorithm for Sparely Deployment and Densely Deployment of Sensor Nodes by varying BS location and initial energy. For Sparely Deployment 80 sensor nodes are considered and for Densely Deployment 160 sensor nodes are considered.

Sparely Deployment of Sensor Nodes within a Sensing Field

- **Network Lifetime**

Figure 3: shows network lifetime of a sensor network in terms of LND with BS placed at (100, 100) and (260,280) and concludes that placing BS out of the sensing field results in lowering network lifetime irrespective of the initial energy of sensors nodes. This is because the distance between CHs and BS increases and as a result of which energy dissipation is faster and thus reduces network lifetime.

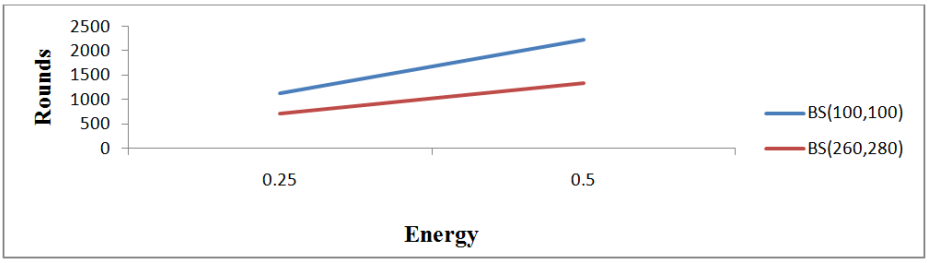

Figure 3: Network Lifetime of a WSN Implementing Routing Protocol Based on Bat Algorithm

- **Packets To Cluster-Heads**

Figure 4: shows total no. of packets sent by sensor nodes to their respective cluster heads throughout the lifetime of the network with BS placed at (100,100) and (260, 280) and concludes that placing BS within the sensing field delivers more packets to CH than placing BS out of the sensing field irrespective of the initial energy of sensor nodes.

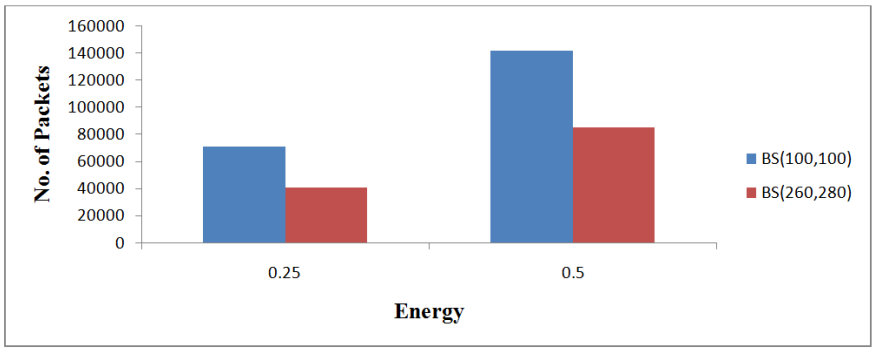

Figure 4: No. of Packets sent to Cluster Head

Densely Deployment of Sensor Nodes

- **Network Lifetime**

Figure 5: shows network lifetime of a sensor network with BS placed at (100,100) and (260,280) for Densely Deployment of sensor Nodes and concludes that for both the initial energy .25J and .5J BS location at (100,100) is prolonging network lifetime than BS location at (260,280).

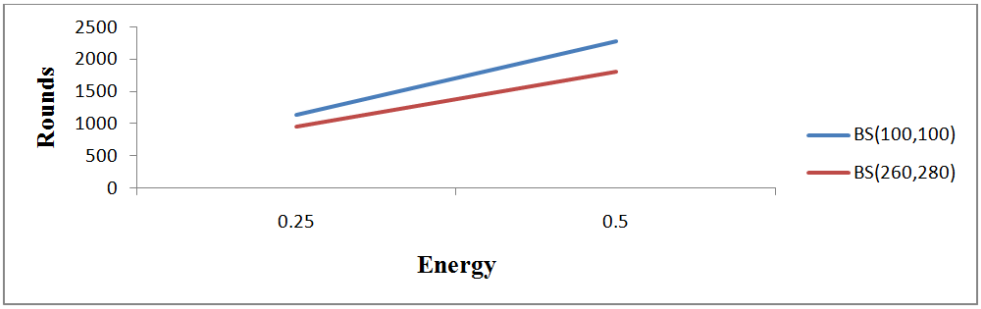

Figure 5: Network Lifetime of a WSN Implementing Routing Protocol Based on Bat Algorithm

- **Packets to CHs**

Figure 6: shows total no. of packets sent by all the sensor nodes to their respective cluster heads throughout the lifetime of the network with BS placed at (100,100) and (260,280) and concludes that placing BS within the sensing field delivers more packets to CH than placing BS out of the sensing field irrespective of the initial energy of sensor nodes because of two factors one is more nodes are deployed and along with this distance between CHs and BS is the other one.

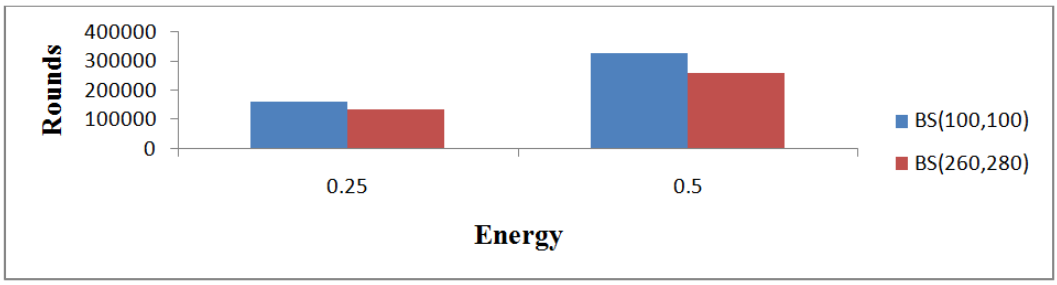

Figure 6: No. of Packets Sent to Cluster Head

CONCLUSIONS

Routing Protocols used in WSN plays a very important role in increasing lifetime of the sensor network .Although various Clustering Protocols have been proposed but along with that we can also use the optimization algorithms for CH selection and ensures longer lifetime to the sensor network.

Implementing Multi-Hop Routing Protocol based on Bat algorithm in a WSN prolongs network lifetime when compared with Modleach and as a result of which more packets are delivered to CH. From the research work performed above following results are summarized for sparely deployment and densely deployment of sensors within a sensing field, that placing BS within the sensing field gives better result than placing BS out of the sensing field irrespective of the initial energy of sensor nodes When BS location was changed from (260,280) to (100,100) then there was increment in network lifetime and no. of packets delivered to CHs for nodes having .25J and .5J of initial energy for both densely and sparely deployment.

This work can be extended by using other optimization algorithms and comparing with the existing work. Along with that optimal location of the Base Station can be found on which the performance of the WSN depends.

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